User's Manual

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INTRODUCTION

GENERAL DESCRIPTION

The MP Series Voltage Controller is a microprocessor based controller designed for controlling motor driven variable transformers. The controller accepts set point and feedback voltage inputs and provides output signals until the feedback voltage matches the set point.

The input set point signal may be any of many different forms of voltage, current or computer interface type signals. The feedback signal may be any of many voltage levels or frequencies. The output signals can be many types including form C type closures, digital or computer interface type signals.

Input signals can be measured using peak, average or RMS techniques with software averaging. Output control can be simple increase/decrease signals. Multiple set points may be programmed using variable speed (time proportioning) ramping with variable dwell.

MODEL NUMBER SYSTEM

The model numbering system gives you information about your MP controller. The following list shows how to determine your controller's configuration from the model number.

Model	Function
MPA	Single channel feedback and control.
MPB	Two independent channels of control and feedback.
MPC	Three independent channels of control and feedback.

Options	Function
T	Microterminal mounted on front door of enclosure.
S	External process control set point. User configurable for 0-1 mA, 4-20 mA, 0-50 mVDC, or 0-10 VDC.
I	Isolated feedback signals and/or isolated process control signal.
2	RS-232C computer interface.
4	RS-422 computer interface for polled operation.
8	IEEE 488 interface.

WIRE CONNECTIONS

Input Power

Connect 120, 240, or 277 Volt AC input power lines (#14 Awg wires max.) to terminals 1 (hot) and 2 (common) of terminal strip at bottom of panel mounted inside the controller (see figure 1).

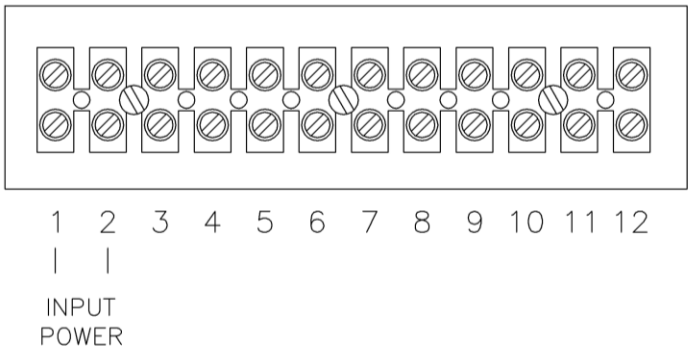


Figure 1

If voltage is other than 120 Volt AC, locate power supply board assembly mounted inside the controller in the upper left hand side. Locate 3 pin headers J3, J4, and J5 on P. C. board (next to fuse) and relocate shunts for the appropriate voltage as per figure 2.

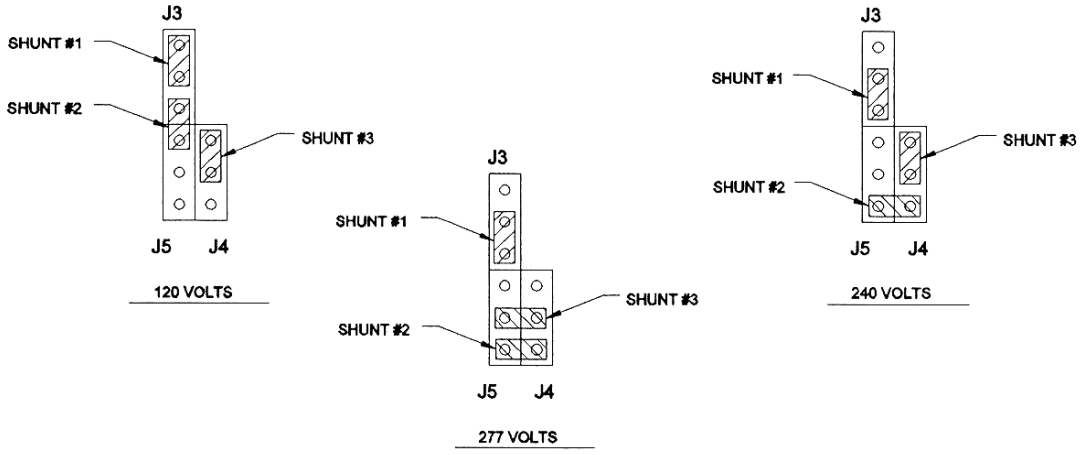


Figure 2

VOLTAGE FEEDBACK SIGNALS(S)

Connect VOLTAGE FEEDBACK SIGNAL sense channels to terminal strip as follows (Figure 3 or 4): Sense channel Phase A to positions 4 and 6, and if three phase option is used, sense channel Phase B to positions 7 and 9 and sense channel Phase C to positions 10 and 12 (#14 Awg wires max.).

The 5 pin connectors at J7 on main microcontroller board and if three phase option is used, connectors J8 and J9 on the lower microcontroller board must be configured based on the selected voltage feedback range (see DIP SWITCHES SW2-1 and 2).

If the 150 or 300 voltage range is selected, the blue/white and black/white leads from the sense transformers must be configured for each transformer respectively (see figure 3).

If the 150 voltage range is selected, place the 5 pin connectors to the left so that pin #1 of the connector matches up with pin #1 of the header on the board and pin #6 of the header on the board is not connected (see figure 3).

If the 300 voltage range is selected, place the 5 pin connectors to the right one (1) position so that pin #1 of the connector matches up with pin #2 of the header on the board and pin #1 of the header on the board is not connected (see figure 3).

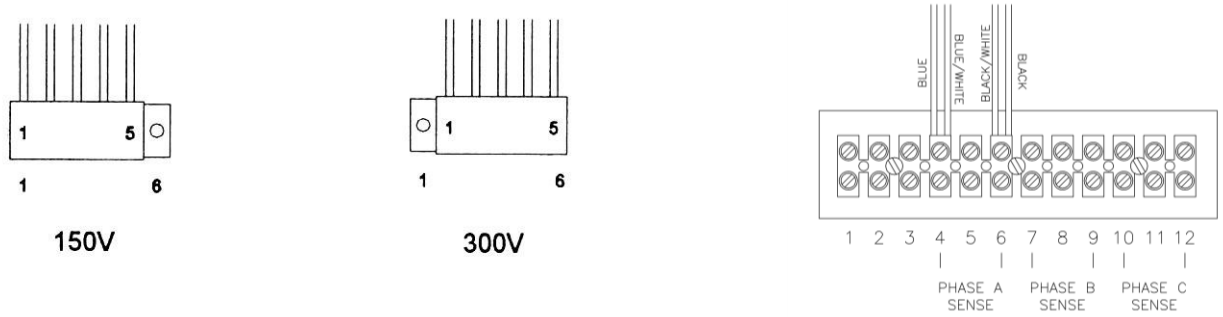


Figure 3

If the 300 or 600 voltage range is selected, the blue/white and black/white leads from the sense transformers must be configured for each transformer respectively, the 5 pin connectors must be positioned as shown (see figure 4).

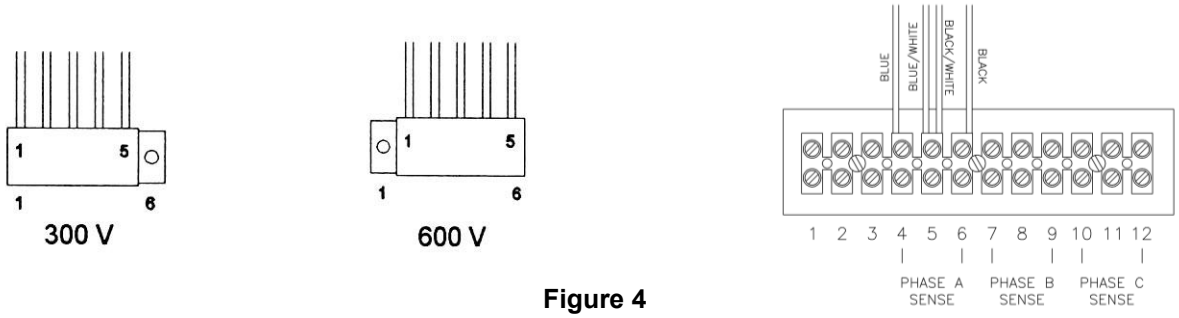


Figure 4

MOTOR CONTROL

The microcontroller is capable of controlling all STACO's motor driven autotransformers. Connect **120 Volt AC power** to **J2-1** on the microcontroller main printed circuit (PC) board, connect **120 Volt AC neutral** to terminal **C** on the variable motor drive terminal strip, connect **J2-2** on the microcontroller PC main board to terminal **R** on the variable motor drive terminal strip, and connect **J2-3** on the microcontroller main PC board to terminal **L** on the variable motor drive terminal strip (see figure 5).

If the THREE PHASE option is being used, connect **120 Volt AC power** to **J3-1** and **J12-1** on the lower microcontroller lower PC board, connect **120 Volt AC neutral** to terminal **C** on the phase B and C variable motor drive terminal strips, connect **J3-2** on the microcontroller lower PC board to terminal **R** on the phase B variable motor drive terminal strip, connect **J3-3** on the microcontroller lower PC board to terminal **L** on the phase B variable motor drive terminal strip, connect **J12-2** on the microcontroller lower PC board to terminal **R** on the phase C variable motor drive terminal strip, and connect **J12-3** on the microcontroller lower PC board to terminal **L** on the phase C variable motor drive terminal strip (see figure 5).

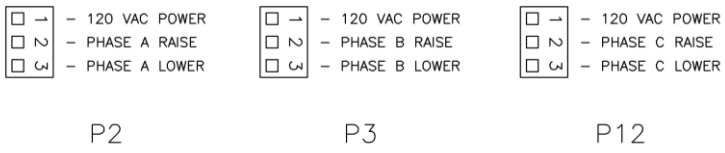

1 – 120 VAC POWER
2 – PHASE A RAISE
3 – PHASE A LOWER
P2
1 – 120 VAC POWER
2 – PHASE B RAISE
3 – PHASE B LOWER
P3
1 – 120 VAC POWER
2 – PHASE C RAISE
3 – PHASE C LOWER
P12

Figure 5

SET POINT INPUT

The microcontroller will accept set input from different sources. The basic unit is supplied with a potentiometer mounted to the enclosure back panel with the wiper connected to connector J1-7 on the main microcontroller PC board, counter clockwise end of the pot connected to J1-6, the clockwise end of the pot connected to J1-9 (see figure 6), and wing resistors R28 and R29 at 0 ohm.

The operating set point also may be controlled using the following options:

S - PROCESS CONTROL SET POINT
T - MICROTERMINAL
2 - RS-232
4 - RS-422
8 - IEEE-488

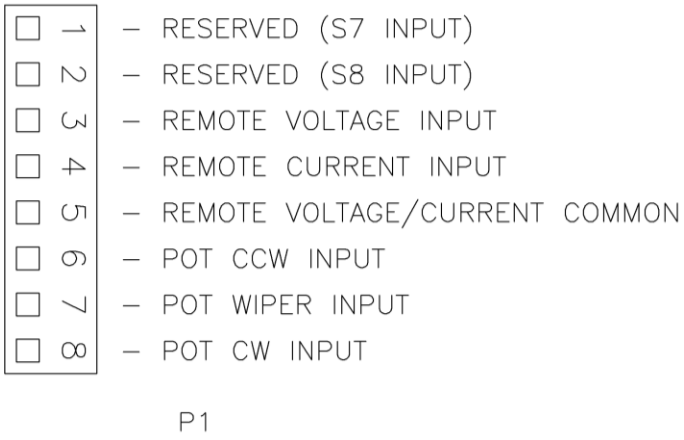

1 – RESERVED (S7 INPUT)
2 – RESERVED (S8 INPUT)
3 – REMOTE VOLTAGE INPUT
4 – REMOTE CURRENT INPUT
5 – REMOTE VOLTAGE/CURRENT COMMON
6 – POT CCW INPUT
7 – POT WIPER INPUT
8 – POT CW INPUT
P1

Figure 6

REMOTE SIGNAL

Low level logic signals (150 ma @ 5 VDC) for raise/lower control, high/low alarms and other functions are available at connector J4 on the main PC board and J5 and J6 on the option board (see fig. 7).

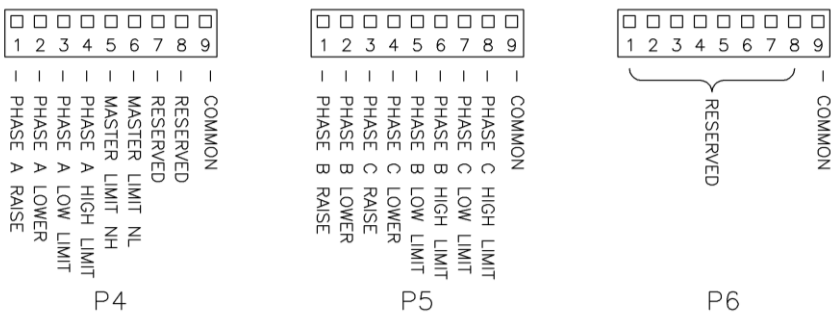

1 2 3 4 5 6 7 8 9
– PHASE A RAISE
– PHASE A LOWER
– PHASE A LOW LIMIT
– PHASE A HIGH LIMIT
– MASTER LIMIT NH
– MASTER LIMIT NL
– RESERVED
– RESERVED
– COMMON
P4
1 2 3 4 5 6 7 8 9
– PHASE B RAISE
– PHASE B LOWER
– PHASE C RAISE
– PHASE C LOWER
– PHASE B LOW LIMIT
– PHASE B HIGH LIMIT
– PHASE C LOW LIMIT
– PHASE C HIGH LIMIT
– COMMON
P5
1 2 3 4 5 6 7 8 9
RESERVED
– COMMON
P6

Figure 7

HIGH/LOW LIMITS

Microcontrollers with either T (microterminal) or 2,4, or 8 (serial interfaces - RS232, RS422 or IEEE) options have available a high and low limit for each phase. These limits will responds to the feedback signal(s) and user programmable limit set points. The output for these limits is a low level logic signal (150 MA @ 5VDC) which is available on P4 for phase A and P5 for phases B and C (see fig. 7).

The limit signal level is "high" (+5VDC) if the limit is in a "safe" condition when the corresponding feedback signal is above the LOW LIMIT or below the HIGH LIMIT. The limit signal is low (0 VDC) if the limit is in a "tripped" condition when the feedback signal is (below the LOW LIMIT or above the HIGH LIMIT for longer than the Alarm On Delay(factory set at 0 seconds or user setable from 2,4, or 8 option table L). Once exceeded the limit(s) will remain in the "tripped" state until the corresponding feedback signal has returned to a "safe" level and the feedback signal is within the preset control deadband for a continuous Alarm Off Delay (factory set at 5 seconds or user setable from 2,4, or 8 option table L).

Refer to OPTION T (microterminal - HIGH/LOW LIMITS) or OPTION 2 (RS-232 - Alarm Table L) for setting set points. All of the HIGH/LOW LIMIT alarms may be monitored or reset with the OPTION 2 , 4 or 8 (ref. Alarm Table L).

A set of MASTER LIMITs are also available on connector P4 (see fig. 7), one normally high (5 VDC = NH) and one normally low (0 VDC = NL). These signals are a summary of all the HIGH and LOW LIMIT alarms. The MASTER LIMITs change state when any of the HIGH or LOW LIMITS go from a safe condition to a tripped condition and return to normal when all tripped alarms are safe.

SET-UP SWITCHES
The microcontroller is capable of operating in several different operation modes with selectable control ranges. The selection of a particular operating mode or range is made by using miniature switch on the microprocessor printed circuit board.

MOTOR SPEED
The microcontroller using pulse width modulation causes the motor on the variable transformer to operate at two speeds (High - range 1 and Low - range 2). The motor is run in High speed when there is a large difference between the signal value and the set point (range 1). When there is a small difference between the signal value and the set point(range 2), the microcontroller will cause the motor to operate at a lower speed relative to the high speed.

The SPEED switches, SW2-8, 7, and 6 determine the operating speed of the motor with FAST being full motor speed for high speed. The relationship between fast and slow is fixed.

RAMPING
The RAMPING switches, SW2-5, and 4 determine a multiplication factor for the times loaded in the ramping table (R). The microcontroller will multiply the time set in the ramping table by the number set by these switches (1, 10, 100, 1000).

SERIAL\ANALOG
The SERIAL\ANALOG switch, SW2-3 determines the source of the set point. Serial selection receives set point information from option T (microterminal), option 2 (RS-232), option 4 (RS-422), or option 8 (IEEE-488). Analog selection receives set point information from the potentiometer mounted on the microcontroller enclosure back panel or from an option S input (process control signal). This switch is used in conjunction with the LOCAL/REMOTE switch.

VOLTAGE RANGE
The VOLTAGE RANGE switches, SW2-2, and 1 determine the gain of the feedback signal and are selected with the placement of J7, J8, and J9. Feedback ranges of 100, 150, 300 and 600 may be selected.

PHASE
The PHASE switch, SW3-7 determines if the microcontroller is controlling one variable transformer motor (1φ) or three independent variable transformer motors.

DEADBAND
The DEADBAND switches, SW3-6, and 5 determine the voltage range where the microcontroller will not make corrections. Ranges of 0.5 Volt, 1.0 Volt, 2.0 Volt and 4.0 Volt may be selected.

AVERAGING
The AVERAGING switches, SW3-4, 3, and 2 determine the number of reading cycles used for averaging readings. These readings are used by the microcontroller for control of the variable transformer.

LOCAL/REMOTE
This LOCAL/REMOTE switch, SW3-1 determines if the set point used by the microcontroller is obtained from an external input source option S (Process Control]) or from a local source [potentiometer (mounted on back panel) or option T (Microterminal)]. This switch is used in conjunction with the SERIAL/ANALOG switch SW2-3.

OPTION S (PROCESS CONTROL SET POINT)

A remote set point voltage of 0 - 10 VDC or 0 - 50 mV may be connected between J1-3 (+) and J1-5, COM (see figure 6). If 0 - 10 VDC is used place jumper W31 on the main PC board to the left and remove any jumper on W32, if 0 - 50 mV is used place jumper W32 to the right and remove any jumper on W31, jumper W26 must be in the left position for a voltage set point input (see figure 8).

A remote current (0 - 1 ma or 4 - 20) input set point may be connected between J1-4 (input) and J1-5, RETURN (see figure 6). If 0 - 1 ma is used place jumper W25 on the main PC board in the left position, place W31 in the right left position, and remove any jumper on W32, if
4 - 20 ma is used place jumper W25 in the right position, place W32 in the left position and remove any jumper on W31, jumper W26 must be in the right position for a current set point input (see figure 8).

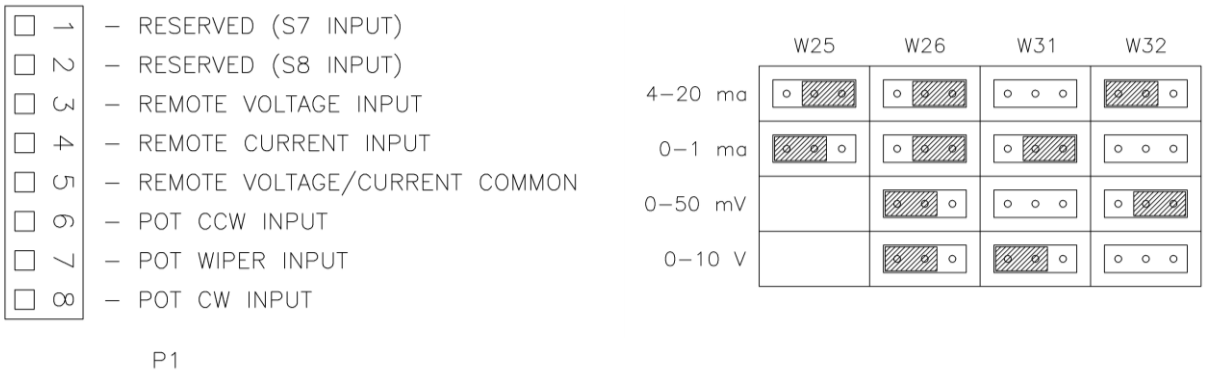
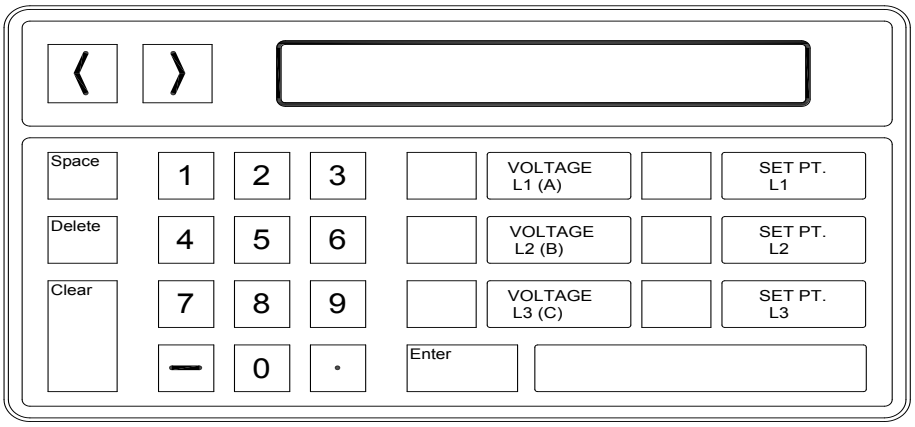


Figure 8

OPTION T(MICROTERMINAL)

The option T microterminal provides for local display of the feedback signal and access to the target set point(s).



DISPLAY SIGNAL (VOLTAGE)
Press the desired phase signal push button and then press the "Enter" push button. For example to select the φA signal for display press <φA Signal><enter>.

DISPLAY SET POINT TARGET
Press the desired phase set point push button and then press the "Enter" push button. For example to select the φA set point press <φA Set point><enter>. The present set point target will be displayed for about 10 seconds and then the display will switch and display the signal.

INPUT NEW TARGET SET POINT
Press the desired phase set point push button and then enter the new set point in integer form and then press the "Enter" push button. For example to input a new φA set point target of 125 press <φSet point><1><2><5><enter>.

THREE PHASE OPERATION
On three phase units, all three phase's set points can be set and displayed by using the number "4" button. To display the common three phase set point press the number "4" button and then press the "Enter" push button. If all three set points are the same, the display will display the set point common to all three phases. If the set points are not the same the display will read "Unmatched SPts".

HIGH/LOW LIMIT SET POINT

High and low limits may be set from the microterminal using the number "5" and number "6" buttons on the terminal (ref. HIGH/LOW LIMITS section).

Press the number "5" followed by the desired set point and the then press the "Enter" button to set all three (if three phase controller - MPBxx or MPCxx) LOW LIMIT set point(s) to the entered value. Press the number "5" and then press the "Enter" push button to display the current LOW LIMIT set point.

Press the number "6" followed by the desired set point and then press the "Enter" button to set all three (if three phase controller - MPBxx or MPCxx) HI LIMIT set point(s) to the entered value. Press the number "6" and then press the "Enter" push button to display the current HI LIMIT set point.

The set point value displayed is for phase 1, the set points for phase 2 and phase 3 will be the same value if the set point was entered from the microterminal. If limit values are being entered from the 2, 4, or 8 options (serial interfaces - RS232, RS422 or IEEE), the values for phases 2 and 3 could be different.

OPTION 2 (RS-232)

The 2 option allows RS-232 communication between the MICROPROCESSOR CONTROLLER and a host computer or terminal. The controller can be a **L**istener, a **T**alker, or **N**either. On power up the controller is **N**either.

Communications protocol with the controller is by an ASCII serial message made up of 1 to 4 elements terminated by an ETX character (03).

<COMMAND><SUBCOMMAND><POSITION><SPACE><VALUE><ETX>

Command, Subcommand and Position are single characters. Value is an integer number from 1 to 65,000. The ETX, message terminator can be sent from a keyboard with Control-C (^C).

If an unrecognizable command is sent, the controller returns a NAK (21). An ACK (06) is returned when a command is recognized. If a timeout is exceeded (10 sec.) before the ETX is sent, the controller sends a NAK.

Before the tables can be accessed the unit must be put into the "Listen" mode. This is accomplished by sending a "Listen" message to the target unit. The message contains the L (listen) A (Address) <SERIAL NUMBER> ETX (ex. L A 1234^C).

COMMUNICATIONS

9600	BAUD
8	DATA BITS
1	STOP BITS
NONE	PARITY
NONE	FLOW CONTROL

PIN ASSIGNMENTS

Pin No.	Description	I/O
1	NC	-
2	Send Data	Output
3	Receive Data	Input
4	NC	-
5	Ground	Ground
6	NC	-
7	NC	-
8	NC	-
9	NC	-

COMMANDS

L Listen
T Talk
S Set table value
R Read table value
G Go
Q Quiet (Neither Talk nor Listen)

SUBCOMMANDS

A Address (only with L or T)
M Mode Table (Read only)
T Target Set point table
V Voltage reading table (Read only)
1,2,3 only with 'G'
R Ramping table

TABLES

Mode Table (M) - reflect setting of DIP switches SW2 and SW3

1. Motor speed
2. Ramping
3. Pot/Serial flag (set point)
4. Voltage range (feed back)
5. Number of Phases
6. Deadband
7. Averaging
8. Local/Remote flag

Target Voltage Table (T)

1. Phase A target
2. Phase B target
3. Phase C target

Voltage Reading Table (V)

1. Phase A voltage
2. Phase A average voltage
3. Phase B voltage
4. Phase B average voltage
5. Phase C voltage
6. Phase C average voltage

Alarm Table (L)

1. Phase A Low Trip Point
2. Phase A High Trip Point
3. Phase B Low Trip Point
4. Phase B High Trip Point
5. Phase C Low Trip Point
6. Phase C High Trip Point
7. Phase A Low Limit Status
8. Phase A High Limit Status
9. Phase B Low Limit Status
10. Phase B High Limit Status
11. Phase C Low Limit Status
12. Phase C High Limit Status
13. Alarm Off Delay
14. Alarm On Delay

Ramping Table (R)

	Set Point Number			
	1	2	3	4
Ramp Time (seconds, max 600)	2	6	10	14
Dwell Time (seconds, max 600)	3	7	11	15
Terminator (1, 2, 3, or 4)	4	8	12	16
Phase A Voltage	1	5	9	13
Phase B Voltage	31	35	39	43
Phase C Voltage	61	65	69	73

EXAMPLES

To put the unit with serial number 0002 into a Listen mode

LA0002^C

To read Mode table position 4 (Voltage range)

RM4^C

To read the present feed back voltage on Phase A

RV1^C

To set a target voltage for Phase A of 115 volts

ST1 115^C

The unit will repeat the received value

115

To tell the unit to Go to the target value in position 1 of the Target table

G1^C

OPTION 4 (RS-422)

The 4 option allows RS-422 communication between the MICROPROCESSOR CONTROLLER and a host computer or terminal. The controller can be a **L**istener, a **T**alker, or **N**either. On power up the controller is **N**either.

Option 4 uses the same communication protocol, communication parameters, commands, subcommands and tables as OPTION 2 (RS-232).

PIN ASSIGNMENTS

Pin No.	Description	I/O
1	+RTS	Output
2	-RTS	Output
3	Ground	Ground
4	+TXD	Output
5	-TXD	Output
6	+CTS	Input
7	-CTS	Input
8	+RXD	Input
9	-RXD	Input

OPTION L (PHASE LOSS)

The L option is a control voltage interface for controlling a power device like a contactor or shunt trip circuit breaker used to shut off power when one or more phases of the supply power drops below a set voltage level . Refer to OPTION T (microterminal - HIGH/LOW LIMITS) or OPTION 2 (RS-232 - Alarm Table) for setting LOW LIMIT set points.

The phase loss OPTION L is controlled by the MASTER LIMIT. This signal is a summary of all the HIGH and LOW LIMIT alarms. The MASTER LIMIT is "high" when all the HIGH and LOW LIMITS are in a safe condition and goes low if any of the these signals are tripped. The MASTER LIMIT will stay low until all limits have returned to a safe level and the feedback signal(s) has been within the set DEADBAND (see SW3-6 and 5) for a continuous 5 seconds (factory set time may be changed with the OPTION 2).

DIP SWITCHES

SW2:

MOTOR	8	1			
SPEED	7	2	0 = SLOW	7 = FAST	
	6	4			
		1	10	100	1000
RAMPING	5	OFF	ON	OFF	ON
	4	OFF	OFF	ON	ON
SERIAL/ANALOG	3	ON = SERIAL		OFF = ANALOG	
		100	150	300	600
VOLTAGE	2	OFF	ON	OFF	ON
RANGE	1	OFF	OFF	ON	ON

SW3:

-	8	Not used			
PHASE	7	ON = 3φ	OFF = 1φ		
		0.5 V	1.0 V	2.0 V	4.0 V
DEADBAND	6	OFF	ON	OFF	ON
	5	OFF	OFF	ON	ON
	4	2			
AVERAGING	3	4	Number of cycles / reading		
	2	16			
LOCAL/REMOTE	1	ON = LOCAL	OFF = REMOTE		

DOWN = TRUE

CALIBRATION OF FEEDBACK SIGNAL

- Apply Calibration voltage to transformer input (see fig 3 or 4).

- Monitor DC value at (ref ground at W35 pin 1 -- exposed pin):

  TP1 for phase A
  TP2 for phase B
  TP3 for phase C

or

Observe microterminal reading for each phase (T option).

or

Query serial port (2,or 4 option):

  table location 1 for phase A
  table location 3 for phase B
  table location 5 for phase C

- Adjust appropriate potentiometer:

  R43 for phase A (main controller board)
  R35 for phase B (option board)
  R59 for phase C (option board)

DC value (at test point) = Calibration voltage / Full Scale * 10

or

Displayed value (microterminal or V table) = Calibration voltage value

CALIBRATION OF PROCESS CONTROL (S OPTION)

- Apply Calibration Signal (see fig. 6)

  voltage at P1-3 (+) and P1-5 (common)

  or

  current at P1-4 (+) and P1-5 (return)

- Monitor DC value at TP4 (ref ground at W35 pin 1 -- exposed pin):

- Adjust potentiometer R-53

  for 4-20 mA: DC value = (Calibration current - 4 mA) / 16 mA * 10

  or

  for 0-1 mA: DC value = Calibration current / Full Scale current * 10

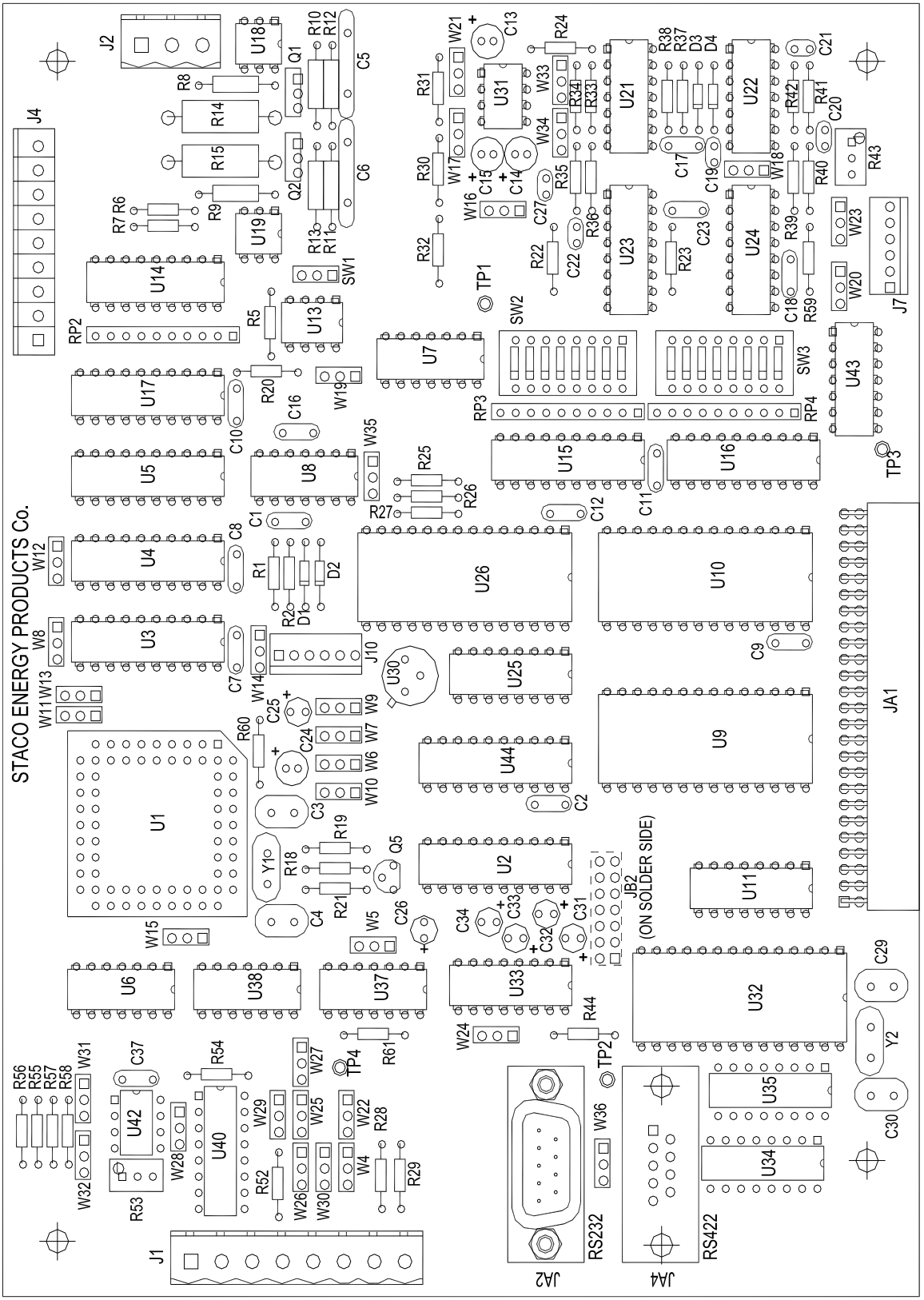
  or

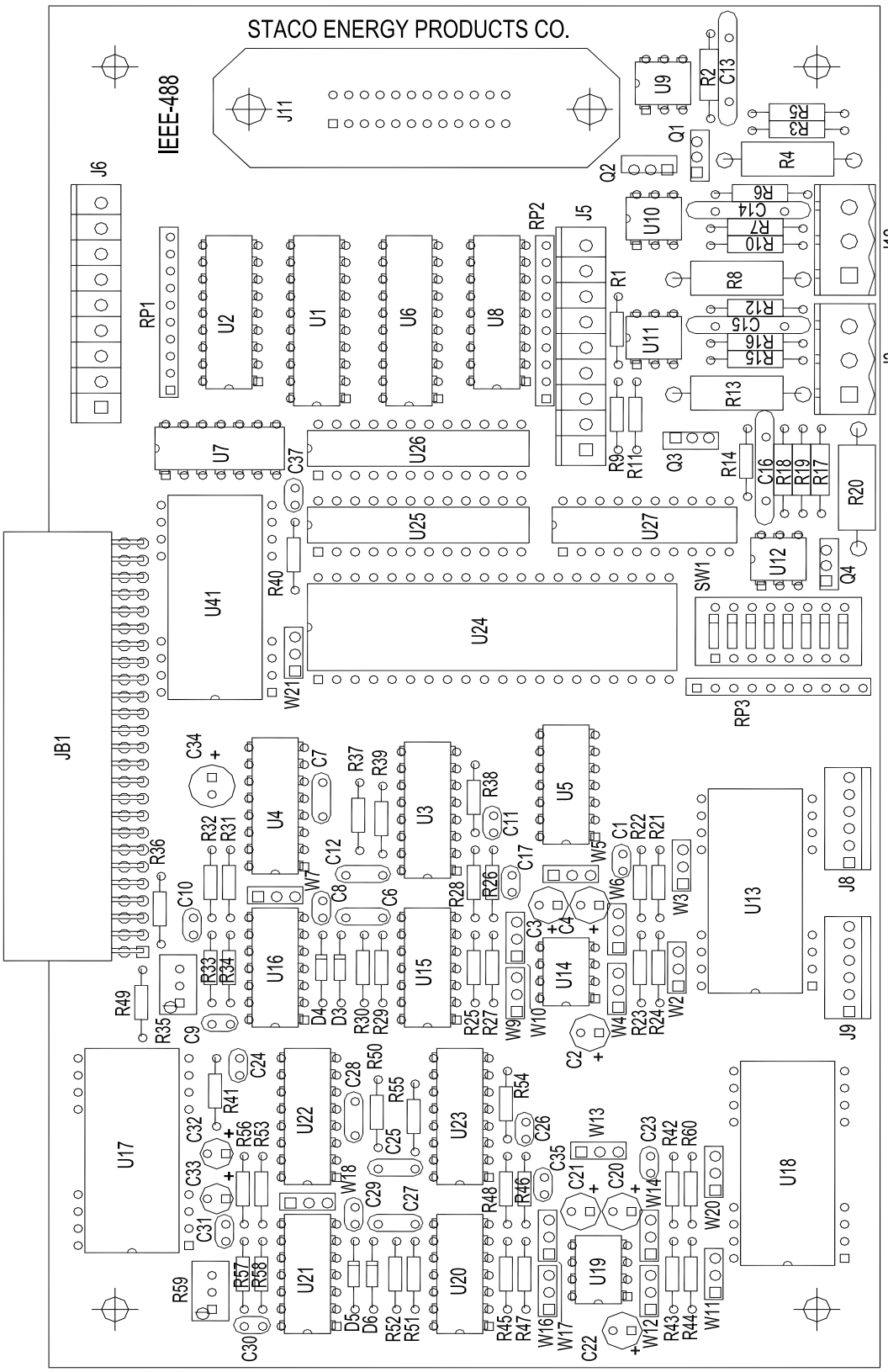
  for Voltages: DC value = Calibration Voltage / Full Scale voltage * 10

Jumper Selection-Main PC Board

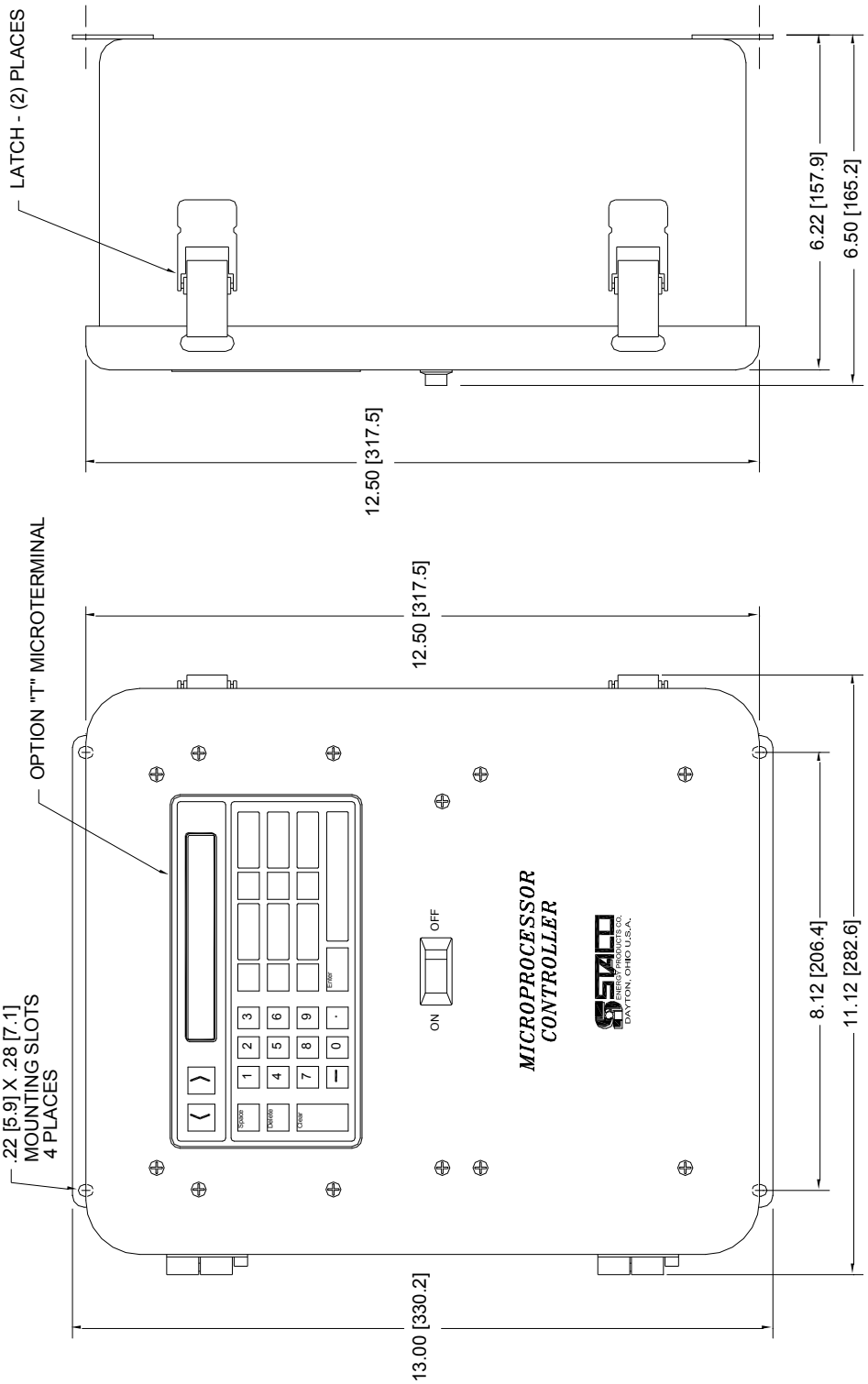
	DEFAULT	FUNCTION
W4		S8 NOT USED
W5		INTO (NO JUMPER)
W6		EPROM
W7		EPROM
W8		EPROM
W9		EPROM
W10		SRAM
W11		SRAM
W12		SRAM
W13		SRAM
W14		EPROM
W15		60 HZ. SAMPLE PULSE
W16		PHASE A: RMS
W17		PHASE A: RMS
W18		PHASE A: PEAK/AVERAGE
W19		120 Hz / 60 HZ
W20		PHASE A: ISOLATION AMPLIFIER
W21		PHASE A: PEAK/AVERAGE - RMS
W22		S7 NOT USED
W23		PHASE A: ISOLATION AMPLIFIER
W24		RS232 - RS422
W25		PROCESS SET POINT: 4-20/0-1 mA
W26		PROCESS SET POINT: CURRRENT/VOLTAGE
W27		PROCESS SET POINT: ISOLATION AMPLIFIER
W28		PROCESS SET POINT: ISOLATION AMPLIFIER
W29		PROCESS SET POINT: ISOLATION AMPLIFIER
W30		PROCESS SET POINT: ISOLATION AMPLIFIER
W31		PROCESS SET POINT: 0-1/0-10
W32		PROCESS SET POINT: 50mV/4-20mA
W33		PHASE A: AVERAGE/PEAK
W34		PHASE A: AVERAGE/PEAK
W35		ANALOG TO DIGITAL GROUND
W36		JSA2-8 CONNECTED TO +5 VDC

Jumper Selection-Option PC Board

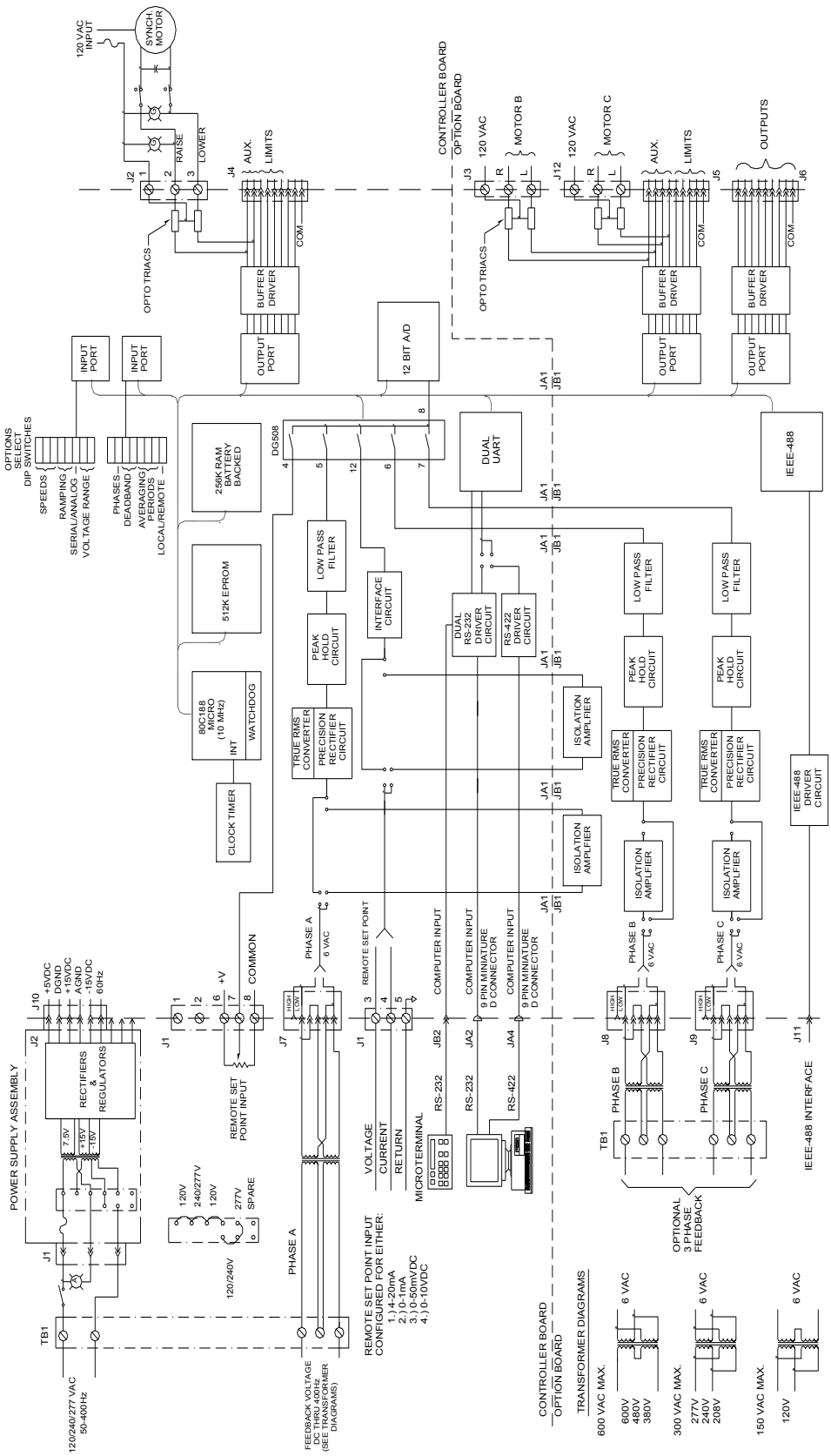

STACO ENERGY PRODUCTS Co.
J1
J2
J4
JA1
JA2
JA4
JB2
(ON SOLDER SIDE)
RS232
RS422
SW1
SW2
SW3
TP1
TP2
TP3
TP4
U1
U2
U3
U4
U5
U6
U7
U8
U9
U10
U11
U13
U14
U15
U16
U17
U18
U19
U21
U22
U23
U24
U25
U26
U30
U31
U32
U33
U34
U35
U37
U38
U40
U42
U43
U44
Y1
Y2
Main Controller Board



Option Board



Microcontroller Enclosure



Microcontroller Block Diagram

NOTES: `````